

It is clear from Fig. 2 that mean breast dot sizes for the Indian and Indo-Chinese subregions are smaller ($x = 1.88 \pm 0.70$, $x = 1.80 \pm 0.78$) than those for Java ($x = 2.1 \pm 0.82$) although the Assam toptype is somewhat larger ($x = 2.1 \pm 0.88$) than the rest of India. However, the sample available for Assam was small and shows wide variation in breast dot size (range 0.5–4.0 mm). The values for India, including Assam, and Java were compared using a 't' test and were shown to be significantly different ($p < 0.001$). The mean dot size of the Malay Peninsula birds ($x = 2.65 \pm 0.65$) falls much closer to the Javan sample and is significantly different from both the Indian and the Indo-Chinese samples ($p < 0.001$).

Thus the population of *Tyto alba* in the Malay Peninsula more closely resembles birds from Java, in terms of breast dot size, than those from the north in the Indian and Indo-Chinese subregions. It is suggested therefore that the present population of *Tyto alba* in the Malay Peninsula has originated from Java, a probability that is supported by the southern distribution of these owls in the Peninsula.

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Fossil birds from Mangaia, southern Cook Islands

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Although Mangaia (21°55'S, 157°57'W) is the second largest of the Cook Islands, published knowledge of its bird life has been meagre, hitherto being restricted to that found in Holyoak (1974, 1976a, 1980). Early missionaries and linguists have noted certain birds on Mangaia (e.g. Gill 1894, Christian 1920, 1924, Te Rangi Hiroa 1934, 1944, Savage 1980), but until the time of my visit the only ornithological research on Mangaia was Holyoak's single day there (24 August 1973), highlighted by the collection of 2 new endemic species, namely a kingfisher (*Halcyon mangaia*) and a sylviiid warbler (*Acrocephalus kerearako*). To initiate a long-term study of the palaeontology, systematics and distribution of vertebrates in the Cook Islands, I visited Mangaia from 26 March to 18 April 1984. An account more detailed than the present awaits further field work.

Mangaia, 20 sq miles (5180 ha), maximum elevation 170 m, has an average annual rainfall of c. 2 m (Survey Dept, Rarotonga 1983). It is a fairly remote island: to the east, the nearest land is Iles Maria of the Austral Group, c. 290 km away; c. 180 km to the west is Rarotonga; c. 185 km to the north are Atiu and Mauke of the Cook Group, while to the south there is no significant land until Antarctica, over 3000 km away.

The most outstanding topographical and geological feature of Mangaia is a ring of limestone 30-60 m high, known as the "makatea", that surrounds the entire island and encircles the highly weathered and eroded volcanic uplands (Marshall 1927, Chubb 1927). The outer rim of the "makatea" is not as steep as the inner rim, which forms a sheer vertical cliff. Between the "makatea" and the volcanic hills is a low-lying area dominated by cultivated swamps of the aroid "taro" *Colocasia esculenta*. Now exposed through renewed uplift of the island during the past several million years, the "makatea" represents an ancient (late Tertiary) coral reef that grew during the long period of subsidence following the volcanic formation of Mangaia c. 19 million years ago (Turner & Jarrard 1982).

The "makatea" is penetrated by numerous caves. A small sample of avian fossils from Te Rua Rere Cave in the Tava'enga District, the first vertebrate fossils from the Cook Islands, were collected in 1983 by Gustav Paulay, whose cooperation stimulated my fossil-collecting there. Te Rua Rere Cave was by far the most productive site, but I collected smaller numbers of fossils from 3 caves in the Ivirua District (Ana Kakai, Te Rua O Ngauru and Toruapuru) and from 2 caves in the Tamarua District (Tapukeu and Tautua). All the fossils were merely lying on the surface of the caves' floors. Two small test pits that I dug in Te Rua Rere Cave were unfossiliferous, but further excavation is planned. Many of the fossils were lying next to bones of similar preservation of the Pacific Rat *Rattus exulans*, brought to Mangaia by Polynesian man, whose skeletons were also lying on the surface. Like other of the southern Cook Islands, Mangaia was settled by Polynesians c. 1000 years ago (Bellwood 1979: 348). Nevertheless, it is difficult or impossible to prove contemporaneity of fossils lying side-by-side on top of, and not within, the sediments of a cave (Steadman in press). The degree of mineralization of the Mangaian fossils varies, but generally is low. Likewise, the amount of calcitic accretion on the fossils is variable, but this is so dependent upon rate of percolation of calcite-charged water (which varies greatly within each cave) that it cannot be considered a safe measure of relative age of the fossils. There is no reason to believe that any of the fossils pre-date the Holocene, and probably all or nearly all are only hundreds or at most several thousands of years old.

The breeding avifauna of Mangaia (Table 1) now stands at 18 species for which specimens have been collected, 9 of them known only from fossils and which almost certainly became extinct within the past 1000 years. Most of the Mangaian species (or very closely related congeners) occur elsewhere in Oceania, but several of them are undescribed forms that probably were endemic. Of the 9 extant breeding species, only 2 (*Egretta sacra* and *Anous stolidus*) were not recorded as fossils. Their absence as fossils may be due to the small size of the fossil collection or may be based upon some aspect of their biology. Except for *Rattus*, the only non-avian fossils were of a fruit bat (*Pteropus* sp, "moa kirikiri") and a gecko (*Gehyra oceanica*, "moko karara"), both of which are common on Mangaia today.

	Recorded in 1973 (Holyoak 1974, 1980)	Whole specimens; 26 Mar – 18 Apr 1984	Fossils from caves
* <i>Pterodroma</i> sp. (small)	—	—	X
<i>Puffinus</i> sp. (small)	—	X	X
* <i>Nesofregatta fuliginosa</i>	—	—	X
<i>Phaethon rubricauda</i>	X	X	X
<i>Phaethon lepturus</i>	X	X	X
<i>Egretta sacra</i>	X	X	—
<i>Anas superciliosa</i>	X	X	X
* <i>Porzana</i> sp. (small)	—	—	X
* <i>Porzana</i> new sp. (large)	—	—	X
* <i>Gallirallus</i> new sp.	—	—	X
<i>Anous stolidus</i>	X	X	—
<i>Gygis alba</i>	X	X	X
* <i>Gallicolumba</i> sp.	—	—	X
* <i>Ducula</i> cf <i>galeata</i>	—	—	X
* <i>Ptilinopus</i> sp.	—	—	X
* <i>Vini</i> cf <i>kuhlii</i>	—	—	X
<i>Halcyon mangaia</i>	X	X	X
<i>Acrocephalus kerearako</i>	X	X	X
Totals	8	9	16
Number extinct	—	—	9

Total number of species from all sources is 18, 9 of them extinct.

Table 1. Extinct and living breeding birds of Mangaia, southern Cook Islands. Holyoak's list is mostly from sight records, including (1980) those from waters near Mangaia for *Macronectes* sp., *Fregata ariel* and *Sterna bergii*, none of which is likely to breed on Mangaia and until substantiated by specimens should be considered as hypothetical migrants or vagrants. Specimens from the caves are bones in varying states of mineralization. Introduced species are not considered. * = extinct on Mangaia.

SPECIES LIST

In the ensuing accounts of the present or formerly breeding species, an asterisk (*) designates taxa that no longer occur on Mangaia. The numbers that follow the species name are, respectively, the total numbers of fossils collected and the minimum number of individuals represented by the fossils. Where known, Mangaian names, based upon my conversations with residents of the island, are given in quotation marks in parentheses following the scientific names.

**Pterodroma* sp. (319, 32)

Fossil remains of this small-sized petrel (about the size of *P. cookii*, *P. leucoptera* or *P. hypoleuca*) were the commonest fossils in the caves, and the first specimens of any species of *Pterodroma* reported from the Cook Islands. Species-level identification awaits more comparative skeletons. The nearest breeding populations of petrels in this size range are *P. leucoptera brevipes* in Fiji and Samoa, *P. macgillivrayi* of Fiji and *P. nigripennis* of the Austral Group (Harrison 1983: 248–250, Watling 1982: 136, 137). Holyoak (1980) reported tentative sight records at sea in 1973 of *P. nigripennis* near Rarotonga and of *P. leucoptera* from somewhere in the southern Cook Islands. At dusk on 30 March 1984, I saw 3 individuals of an undetermined species of *Pterodroma* flying over the sea, c. 50 m beyond Mangaia's fringing reef.

Puffinus sp. ('Rakoa') (10, 3)

This small shearwater is of the *lherminieri/assimilis* species group, the systematics of which are poorly understood. A fledgling, the only individual I saw, was collected from a crevice in the inner cliff of the makatea near

Tamarua Village on 13 April 1984. Residents of Tamarua reported seeing the "rakoa" commonly at dusk. This is the first whole specimen or breeding record for *P. lherminieri/assimilis* from the Cook Islands. Small shearwaters assigned to *P. assimilis* nest on Rapa in the Austral Group (Bourne 1959), whereas *P. lherminieri* breeds in the archipelagos of Fiji, Samoa, Society, Tuamotu and Marquesas (duPont 1976: 16). Holyoak (1980) reported sight records of *P. lherminieri* at sea in 1973 from somewhere in both the southern and northern Cook Islands.

**Nesofregetta fuliginosa* (3, 1)

Fossils from Toruapuru Cave include the very distinctive tarsometatarsus of *N. fuliginosa*, which is much larger and more laterally expanded than in any other species of Oceanitidae. This large storm-petrel breeds in Fiji, Samoa, Phoenix, Line, Austral, Gambier and Marquesas (duPont 1976: 18, Harrison 1983: 271), but the bones from Mangaia are the first specimens or probable breeding record from the Cook Islands. Holyoak (1980) reported sight records of *N. fuliginosa* at sea in 1973 from the northern Cook Islands.

Phaethon rubricauda ("Tavake") (1, 1)

Phaethon lepturus ("Pirake") (1, 1)

These 2 tropicbirds are fairly common, or at least are rather conspicuous, on Mangaia today, both nesting on the inner cliff of the makatea. They are widespread in the Cook Islands and most of Oceania. No evidence of breeding at the time of my visit was found for *P. lepturus*; a specimen of *P. rubricauda* taken on 11 April had slightly enlarged ova.

Egretta sacra ("Kotuku") (0, 0)

This heron is common in the shallow water between the shore and fringing reef, as well as in the taro swamps of the interior. Dark-phased birds outnumber white birds by c. 4: 1. *E. sacra* has been recorded from most of the Cook Islands and much of Oceania.

Anas superciliosa ("Mokora") (2, 1)

This duck is common in the taro swamps and adjacent agricultural land. Holyoak (1980) estimated that fewer than 100 were present in August 1973. In March and April 1984 there were 100-300.

Porzana aff. tabuensis ("Mo'o mo'o") (35, 4)

The "mo'o mo'o" is a small, black rail that lives in and near the taro swamps, probably *P. tabuensis* or an endemic derivative thereof. The Mangaian describe it as shy and elusive (much more often heard than seen) and remarked on its extreme rarity. I did not see one alive. Specimens of *P. tabuensis* have not been taken in the Cook Islands, although Holyoak (1980) had sight records from Atiu and Mitiaro, and stated (p 27) that it "... may well also be present on Mauke and Mangaia and possibly elsewhere". An associated skeleton (31 bones) of a small species of *Porzana* from Toruapuru Cave was similar to a modern skeleton of *P. tabuensis* from Tonga, but slightly larger in the leg elements. *P. tabuensis*, which is capable of flight, is widespread in Polynesia, and has been listed from Samoa, Tonga, Niue, Austral, Society, Tuamotu, Ducie and Oeno (duPont 1976: 42).

**Porzana*, new sp (11, 6)

Associated wing and leg bones were recovered for 2 individuals, to be described elsewhere as a new species (Steadman in prep). This extinct rail was larger (based upon leg bones) than *P. tabuensis*, but had wing elements too

small for flight. It is very similar in size to the living *P. atra* of Henderson Island, but has the pectoral elements reduced even more than in that presumably flightless species. The Mangaian fossils suggest that perhaps 2 species of *Porzana* once inhabited many of the islands in eastern Polynesia, the smaller being *P. tabuensis* or its derivative, and the larger, more flightless one being very similar to *P. atra*.

* *Gallirallus*, new sp (4 specimens, 1 or 2 individuals)

An associated tibiotarsus and tarsometatarsus and an isolated mandible and coracoid represent this undescribed flightless species (Steadman in prep). This is the first record of any form of *Gallirallus* from eastern Polynesia, except for a painting by Johann Georg Adam Forster in 1773 or 1774 (Captain James Cook's second voyage) of a rail from Tahiti known as *Galirallus pacificus* (Gmelin) (= *G. ecaudata*), for which no specimens other than the painting exist (Lysaught 1959: 302, Olson 1973). The nearest living populations of any species of *Gallirallus* are those of *G. philippensis* from Fiji, Rotuma, Samoa, Tonga and Niue (duPont 1976: 40).

* *Anous stolidus* (''Ngoio'') (0, 0)

As reported for St Helena, Ascension and Hawaii (Olson & James 1982), the lack of fossils of *Anous* may be related somehow to their nesting habits. This tern is very common in the coastal and makatea regions of Mangaia, often nesting in Coconut Palms *Cocos nucifera*. Downy young were present in March and April 1984. Holyoak (1980) estimated that fewer than 100 lived on Mangaia in August 1973; 500-1000 were present during my visit.

Gygis alba (''Kakaia'') (111, 15)

This small tern is Mangaia's most common seabird. It is found abundantly throughout the island, nesting on cliffs, in various species of trees, but perhaps most often in Coconut Palms. Adults were feeding fledged young in March and April 1984. Holyoak (1980) estimated there were fewer than 100 in August 1973; 1000-2000 were present during my visit.

* *Gallicolumba* sp (1, 1)

A columbid femur from Te Rua Rere Cave represents a species of *Gallicolumba*, but species-level identification requires more fossils and comparative skeletons. This femur is slightly smaller than the only one available in a skeleton of *G. stairi*, a male from Ofu, American Samoa. *G. stairi* is known also from Fiji, Samoa and Tonga (duPont 1976: 71), with females significantly smaller than males, so the fossil femur may represent *G. stairi* or perhaps *G. erythroptera*, a species of similar size from the Society and Tuamotu Groups. The fossil femur is much larger than that in *G. rubescens* of the Marquesas, the only other species of *Gallicolumba* in Polynesia. No species of *Gallicolumba* has been reported before from the Cook Islands.

* *Ducula cf galeata* (2, 1)

This pigeon was recorded in Te Rua Rere Cave only from 2 coracoids that are larger than in *D. pacifica* or *D. aurorae*, and seem, but without direct comparison, to be the size of those in *D. galeata*, an extremely rare species known historically only from mountain forests of Nuku Hiva (Marquesas), c. 2500 km northeast of Mangaia. *D. galeata* has also been reported from archaeological remains on remote Henderson Island, c. 2000 km southeast of Nuku Hiva (Steadman & Olson MS). It is likely that most species of *Ducula*, *Gallicolumba* and *Ptilinopus* were more widespread in eastern Polynesia in

prehistoric times than now. Mंगाians told me of the former occurrence (before their own lifetimes) of the "rupe", which may have been transported by man to Mangaia, they say, from Rarotonga. Elsewhere in the Cook Islands, "rupe" refers to *D. pacifica*, which is found on most of the southern Cook Islands except Mangaia (Holyoak 1980).

**Ptilinopus* sp. (1, 1)

A single femur from Te Rua Rere Cave is referable to a species of *Ptilinopus* about the size of *P. rarotongensis* or *P. purpuratus*. More specimens are needed to determine the species. No skeletons of *P. rarotongensis* were available for comparison, but the Mangaian fossil could not be distinguished from a female specimen of *P. purpuratus coralensis* from Toau Island, Tuamotu. *P. rarotongensis* is endemic to the Cook Islands, known historically from Rarotonga and Atiu (Holyoak 1980); also Bloxam (1925: 86) noted a species of *Ptilinopus* on Mauke in 1825, for which no specimens apparently exist, although it may have been *P. rarotongensis*, since Mauke is only c. 65 km from Atiu. *P. purpuratus* is found throughout the Society and Tuamotu Islands, but is not known from the Cook Islands. On Rarotonga and Atiu, *P. rarotongensis* is known as the "kukupu". None of the Mंगाians that I interviewed knew of the past occurrence of the "kukupu" on their island.

**Vini* cf *V. kublii* (1, 1)

A nearly complete sternum is inseparable from that of *V. kublii*, but cannot be distinguished with certainty from that of *V. australis*. It is much larger than in *V. peruviana*. Skeletons of *V. ultramarina* and *V. stepheni* were not available. *V. kublii* occurs naturally only on Rimatara Island in the Austral Group, c. 480 km east of Mangaia. The nearest occurrence of *V. australis* to Mangaia is on Niue Island, c. 1300 km to the west-northwest. There are no native psittacids in the Cook Islands today. (*V. peruviana* on Aitutaki is almost certainly introduced by man from the Society or Tuamotu Islands.) Nevertheless, native words for parrots exist in the early language of Rarotonga and Mangaia (Savage 1980: 123, 165). Very likely *V. kublii* or a related species once occurred throughout the southern Cook Islands.

Halcyon mangaia ("Tanga'eo" or "Tangaa'eo," not "Ngotare" as stated by Holyoak 1980) (26, 4)

This kingfisher is sparsely distributed in the forested regions of Mangaia, from the coastal forest, where it is commonest, through the makatea and into the highlands, where it is least common. It usually occurs in pairs and is seen most often at the edge of the forest. All Mंगाians have noted a decline in the numbers of *H. mangaia* over the past 1-2 decades, blaming this on predation and competition from *Acridotheres tristis*, an Asian mynah that was introduced to Mangaia from Rarotonga in the early or mid-1960's, numbered today in the thousands. Holyoak (1980) estimated that 100-1000 individuals of *H. mangaia* existed in August 1973; 100-300 were present in March and April 1984.

Acrocephalus kerearako ("Kerearako" or "Bush Canary") (2, 2)

This sylviid warbler is common in any sort of forested region, even in the small patches (1 acre or less) of *Hibiscus* in the taro swamps and along streams in the volcanic interior. In March and April 1984, *A. kerearako* was found in pairs, usually with a single fledgling still being fed by the parents. Recently abandoned nests were collected from citrus trees in Oneroa Village and from an

unidentified tree in the makatea forest. Holyoak (1980) estimated that 100-1000 existed in August 1973; 500-1500 were present during my field work, which was at the end of the breeding season, when the population should have been at its maximum.

DISCUSSION

Other species of birds may breed on Mangaia today but have gone undetected. For the tern *Procelsterna cerulea*, Holyoak stated (1980: 32) "... possibly also nests at Mangaia", but provided no evidence; he used the local name "kara'ura'u" for *P. cerulea*, but the descriptions of the "kara'ura'u" given to me by various Mangaians were not particularly suggestive of *P. cerulea* or any other known bird. Christian (1920: 87) described "kara'ura'u" merely as "a sea-bird".

The "titi" is a seabird that Mangaians say is similar or identical to the New Zealand "muttonbird"; although rare today, it formerly nested in large numbers in burrows in the soft soil of Mangaia's volcanic uplands. I found no specimens, living or fossil, of the "titi" in spite of specific searches for it. Christian (1920: 87) described it as "a bird living in the rocks and crags. Much relished for food, cf Maori *Titi*, the Mutton-bird". I believe that the "titi" is likely to be a species of *Puffinus*, perhaps *P. pacificus* or *P. nativitatis*. The specimen of the *Puffinus lherminieri/assimilis* group collected from a crevice in the makatea cliff (see above) was called "rakoa" by the Mangaians, who noted that the "rakoa" is similar to, but slightly smaller than, the "titi". In New Zealand and the Kermadec Islands, the name "titi" has been applied to both *P. assimilis* and *P. griseus*, whereas the name "mutton-bird" has been applied to *P. griseus* and *P. tenuirostris* (Oliver 1955: 126, 130, 131). Based upon their known breeding ranges, neither *P. griseus* nor *P. tenuirostris* seem likely to nest on Mangaia.

The "upoa" is another seabird known to some Mangaians today, but is generally regarded as rare and, like the "titi" and "rakoa", is heard only at night. Elsewhere in Polynesia, "upoa" or its local equivalent name refers to a species of *Pterodroma*. The "upoa" could be the small species of *Pterodroma* that occurs commonly as a fossil, or it could be one of several larger species of *Pterodroma* that may have nested on Mangaia in the recent past.

"Kaua" was listed by Christian (1920: 87) as a "sea-bird" without further comment, but he later (Christian 1924: 13) defined "kaua" as "a land bird formerly revered as a divine messenger of peace (unidentified)". I did not ask any Mangaians about the "kaua".

Future palaeontological work on Mangaia promises to be productive. Several of the 9 extinct species are known only from 1-2 bones and more fossils are needed before their morphology and systematics can be described in detail. Many caves remain unexplored for fossils, and even those already explored have not been excavated thoroughly. Based upon species living elsewhere in the South Pacific, and upon those taxa already found as fossils, other species in the following genera may well be found as fossils on Mangaia in due course: *Pterodroma*, *Puffinus*, *Porphyrio*, *Ducula*, *Ptilinopus*, *Tyto*, *Collocalia*, *Lalage*, *Pomarea*, *Clytorhynchus*, *Pachycephala*, *Foulehaio* and *Aplonis*.

Because human impact seems to be involved in nearly all cases of Holocene avian extinction on islands, it is essential for the understanding of such extinction to draw upon evidence from cultural information (linguistics, legends, archaeology, etc). Reciprocally, palaeontological identifications will

assist anthropologists to recognize more easily the biotic resources (such as sources of protein) available to aboriginal peoples when they first set foot on a new island. Research on insular cultures and biotas by the 2 disciplines should never be separated.

It may be thought remarkable that an island as remote and small as Mangaia could have supported at least 18 species of breeding birds until probably only hundreds of years ago, but this situation parallels that of other islands where a thorough record of past birds has been compiled from both palaeontological and archaeological sources, such as in Hawaii (Olson & James 1982, 1984), New Zealand (Anderson 1984, Cassels 1984, Trotter & McCulloch 1984) or Antigua (Steadman *et al* 1984). Exploring caves on only 8 of my 23 days on Mangaia enabled me to double the island's recognized avifauna, without giving reason to believe that every extinct species had been found or that the level of extinction in Mangaian birds was any greater than on most other Pacific islands. More species and populations of birds became extinct in Oceania in the past millenium than exist there today; but only through combined studies of bones from archaeological and palaeontological sites will we understand the distribution of these birds before man disrupted their fragile ecosystems.

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A new subspecies of the babbler *Malacocincla abbotti* from the Eastern Ghats, India

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The Vernay Scientific Survey conducted a thorough avifaunal exploration of the Eastern Ghats, the chain of low mountains that parallels the eastern coast of India (c. 16°-18°N, 80°-83°E) (Whistler & Kinnear 1930, 1932). This major expedition uncovered a surprising diversity of previously undescribed forms. Many of these were relict montane populations, similar in nature to the assortment of upland species that inhabit the Western Ghats, and whose affinities link them to the avifauna of the northeastern hill states and Burma.

In 1981, and again in 1983, field trips jointly sponsored by the Smithsonian Institution and Bombay Natural History Society were made to the Eastern Ghats of the Visakhapatnam District, Andhra Pradesh. Among the new distributional records made during this survey was the discovery of an isolated